INFORMATION CIRCULAR 35

Pennsylvania Geological Survey

Fourth Series

GEOLOGIC INTERPRETATION OF AEROMAGNETIC MAP ELVERSON QUADRANGLE

by

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FOREWORD

Southeastern Pennsylvania is an area of extremely varied and complex geology with a long history of mineral production. The list of mineral commodities which this area has yielded at various times is considerable, but iron-ore stands out as the most prominent. Scores of iron mines and furnaces have operated in this area in the past 200 years. With a record of production dating back to Pre-Revolutionary War years, the mine at Cornwall is America's oldest continuously operating iron mine in the United States. The recent development of the large and magnificent Grace Mine at Morgantown is living testimony to the fact that Pennsylvania's metallic mining record is not simply a story of the past. Through modern methods of exploration and research, new mineral resources remain to be found.

The Bureau of Topographic and Geologic Survey of the Department of Internal Affairs is pleased to have participated and cooperated with the U. S. Geological Survey in carrying out an aeromagnetic survey of Southeastern Pennsylvania. This modern exploration technique is particularly well suited to the geologic conditions and to the potential mineral resources of the area; it is an extremely efficient method of acquiring geologic data for a large region. The results of the aeromagnetic survey are being published by the U. S. Geological Survey as a series of aeromagnetic contour maps.

We are pleased to present this publication as a service to the Commonwealth of Pennsylvania. It is hoped that this interpretation and discussion of the aeromagnetic maps will serve as a stimulus for further research and development.

Genevieve Blatt

Genevieve Blatt, Secretary
Department of Internal Affairs

GEOLOGIC INTERPRETATION OF AEROMAGNETIC MAP
ELVERSON QUADRANGLE

General Statement

The magnetic contour maps being discussed in this series of publications are the result of a cooperative project of the United States Geological Survey and the Pennsylvania Geological Survey, Department of Internal Affairs. About 10,000 square miles of southeastern Pennsylvania have been covered in this survey, the results of which are being published as individual $7\frac{1}{2}$-minute quadrangle maps.

This information circular is one of a series intended as a preliminary explanation of the interrelation of distinctive magnetic features with geological conditions in each quadrangle. In many instances unusual magnetic patterns can be explained by geological features which have been mapped and studied in the past. It is hoped that the map viewer will not only be aided by such correlation of data, but that this publication may stimulate exploration and research in those areas where there is at present no known or satisfactory geological explanation for some of the magnetic features which appear on the magnetic contour map. Such exploration and research could directly or indirectly lead to discovery and development of new mineral deposits and would greatly further the basic knowledge of the geology of Pennsylvania.

The magnetic contour lines on the map are lines connecting points of equal magnetic intensity. The shape, position, and spacing of the magnetic lines are due to the combined effects of the earth itself, which is a huge magnet, and to the local variations in the magnetism of the rocks underlying any given area. If only the earth as a large, uniform body were responsible for the magnetic lines, they would be essentially straight and simple. It is the local geology, however, which imparts complexities to the patterns of the magnetic lines. Such complexities or variations from a simple pattern are called anomalies.

Local magnetic effects vary from place to place because the magnetic properties of the respective rocks are not alike or because differences in rock structure from place to place change the magnetism measured at the surface. Rocks which have different kinds or different relative amounts of minerals, particularly iron-bearing minerals, have unlike magnetic properties. In general, the more iron minerals present, the stronger the magnetic effect. The iron oxide mineral, magnetite, has a strong magnetic effect even when present in small quantities; when present in large amounts, magnetite is of economic interest as a possible iron ore.

If in a given area the rocks have been folded or faulted by internal earth forces, the resulting variation in position of the different rocks will be indicated by variation in magnetic readings from place to place. Thus, structural complexities as well as mineral variations may be revealed by the magnetic data. Of particular interest are those magnetic variations or anomalies which are circular or tend to enclose a given area; the implication in such cases is that there is a specific, localized causative factor more or less pin-pointed by such a pattern.

The aeromagnetic survey of southeastern Pennsylvania was carried out with the use of an airborne magnetometer, an instrument towed by a plane. The plane covered the area by flying back and forth along straight, parallel flight lines spaced a quarter mile apart. An attempt was made to maintain an elevation of 500 feet, above the ground so as to eliminate magnetic changes due solely to terrain changes. An airborne magnetic survey has the advantage of eliminating very minor magnetic features on the ground, thus permitting a better evaluation of larger and deeper magnetic phenomena. It should be borne in mind that the instruments which have measured the magnetic effects in these studies are very sensitive and capable of detecting small changes. Proper evaluation of these changes is necessary to distinguish those situations which offer possibilities for economic mineral development from those cases where the information yielded is of more academic interest.

Elverson Quadrangle
U. S. Geological Survey Aeromagnetic Map G. P. 221

The Elverson aeromagnetic contour map exhibits a pattern of magnetic lines which relates fairly well with the known geological conditions of the area. An east-west trending belt of distinct, elliptical anomalies across the south-central portion of the map corresponds with a belt of of old iron mines.

The southern edge of the map shows only a few widely spaced anomalies despite a considerable variety of rock formations which have been mapped there. This indicates that those rocks are uniform in their magnetic intensity and that there are no indications of iron concentrations there.

The northern half of the quadrangle, except for the northeast corner, shows very few magnetic contours; it is an area underlain by a thick sequence of Triassic sandstones and shales.

Cutting diagonally across the northeast corner of the map in Union Township is an elongate, positive magnetic anomaly over a half mile wide and extending for about four miles on this map. This is located directly over the outcrop belt of a dipping diabase dike. The high points of the anomaly are centered over the diabase. The diabase contains a considerable amount of iron-bearing minerals, including some magnetite, which are responsible for the magnetic anomaly. There is no indication in this area that contact metamorphic effects have increased the magnetic intensity of the adjacent sediments. The anomaly over the diabase has a maximum amplitude of 300 gammas, which together with the nature of the rock type does not offer any encouragement for economic concentrations of iron.

A little less than a mile southeast of Joanna in Caernarvon Township is a small, sharp positive magnetic anomaly. It is about 1000 feet in diameter and has an amplitude of 600 gammas. This is the location of two former small iron mines, the Jones and Kinney mines; a couple of water filled pits within the anomaly area mark the locations of those old workings. These mines have been described by Spencer (1908).

The magnetite ore replaced limestone which is here in contact with diabase. The anomaly indicates that a definite concentration of magnetite still exists at a relatively shallow depth at this location. However, the size of the iron ore concentration appears to be fairly small; just how large it is or what the ore grade is would have to be resolved by exploration drilling.

A half mile south of Joanna and only a half mile west of the Jones-Kinney anomaly described above, is a circular positive magnetic anomaly nearly a half mile in diameter with an amplitude of 250 gammas. No former mine is recorded at this location. The surface rock is diabase which may be fairly thin here and could be underlain by either sandstone or limestone. This anomaly strongly suggests a magnetite concentration but the low amplitude and gentle gradient of the anomaly are not encouraging as to ore grade or depth. Here too, more exploratory work would clarify the picture.

Two elliptical positive magnetic anomalies occur within a half mile of Elverson; one is due east and the other is to the south. Each of these is a half mile long. The more southerly one occurs over a point where metamorphic gneiss, igneous quartz monzonite, and sedimentary sandstone all meet. The more easterly of these two anomalies occurs over the contact of quartz monzonite with Triassic sandstones. Neither of these environments is conducive to major iron concentrations and the low amplitude of the anomalies does not suggest any significant concentrations.

About a mile west of the town of Warwick is a somewhat elliptical positive anomaly nearly a mile in diameter with an amplitude of 350 gammas. This anomaly is located over the site of the old Hopewell iron mine described by Bascom and Stose (1938); the mine was closed in 1914 when the ore was reported exhausted. The magnetite ore occurred as a replacement of a bed within Pickering gneiss; the ore-bearing layer reportedly averaged 30 feet in thickness and dipped to the northwest. The anomaly indicates that some magnetite still remains, but the relatively small amplitude and gentle gradient of the anomaly are not encouraging as to economic possibilities.

A half mile east of Pine Swamp in Warwick Township the map shows a sharp, nearly elliptical shape anomaly; it is nearly a mile long, three quarters of a mile wide and has an amplitude of a little over 1000 gammas. Though not quite as large in area or amplitude as the Grace Mine anomaly, it comes closer to it than any of the other anomalies in this district. Bascom and Stose (1938) report two abandoned iron prospects within a mile to the northeast - in both cases the ore zones were replacements of calcareous beds within the Pickering gneiss. This impressive Pine Swamp anomaly lies on ground which has been owned by an active mining company for several years.

A half mile east of the town of Warwick, the map shows the peak of a fairly broad but gentle positive anomaly; the amplitude is only about 200 gammas. This is within a few hundred feet of the location of the old Warwick iron mine described by Bascom and Stose (1938). It is reported that the mine was worked for over 100 years; both surface pit and underground workings were developed. The magnetite ore zone was a shallow bed of variable thickness, reaching a maximum of 25 feet and is reportedly (Spencer 1908) a replacement of a calcareous bed within the Triassic sandstones. The low amplitude of the anomaly tends to support the historical accounts which indicate that most of the good ore was mined out at this locality. The present indications do not offer encouragement for any more economic iron concentrations at this locality.

Bibliography

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